REMARKS

In the Office Action, the Examiner rejected claims 59-64 under 35 U.S.C. §112, first paragraph, for failing to comply with the enablement requirement. The Examiner also rejected claims 59-74 under 35 U.S.C. §102(b) as being anticipated by United States Patent 4,782,193 issued to Linsker (Linsker). Applicants have amended claims 59, 61-62, and 64-74. Also, Applicants have added new claims 75-82. Thus, claims 59-82 will be pending in the application after entry of this Amendment.

I. Claim Rejections under 35 U.S.C. §112, first paragraph

Claims 59-64 were rejected under 35 U.S.C. §112, first paragraph, for failing to enable the claim limitation "determining a ratio of first interconnect … to create a simulated Euclidean interconnect … wiring angle," in claims 59 and 62. *See* Office Action, page 2, paragraph 3.

Applicants respectfully traverse this rejection. Specifically, Applicants respectfully submit that the specification and drawings of the present application thoroughly describe how some embodiments of the invention identify and use a ratio of wire segments along two directions based on a desired wiring angle. Applicants respectfully direct the Examiner's attention to the section entitled "Euclidean Wiring" at pages 38-45 of the specification in the present application, and its corresponding figures 17-24. For instance, pages 40-43 of the specification disclose:

> <u>Simulated Euclidean With Gridless Non Manhattan Routing</u>
>
> To provide an even better simulation of Euclidean wiring, it would be desirable to use 45° angle line segments. Manufacturing 45° angle segments are not a severe stretch from existing manufacturing techniques since 45° angle segments can be created by moving a single unit in both the horizontal and vertical directions.
>
> **Figure 18a** illustrates a small gridded non Manhattan interconnect line that uses 45° angle segments. The interconnect line of **Figure 18a** consists of two

separate 45° angle segments joined by one horizontal segment. The three interconnect line segments of **Figure 18a** simulate a direct interconnect line with angle A. With a gridded system, the number of angles that may be represented is limited by the detailed routing grid. For example, **Figure 18b** illustrates the next smallest angle that may be created for an interconnect line that is no more than two detailed routing grid units high. As illustrated in **Figure 18b**, the horizontal segment was extended to the next detailed routing grid intersection.

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Simulated Euclidean With Non Manhattan Layers

To simulate any angle wiring with non Manhattan layers, one implementation of the present invention uses a mix of Manhattan and 45° angle diagonal interconnect lines as show in Figures 18c through 18f. For example to create interconnect lines with an angle between zero and forty-five degrees, the system uses a mix of horizontal and 45° angle diagonal interconnect lines. Figure 19a illustrates how an interconnect line of angle A (an angle between zero and forty-five degrees) may be simulated.

Figure 19a illustrates a first method of calculating the lengths of the two sections. Referring to **Figure 19a**, an interconnect line with angle A (an angle between zero and forty-five degrees) is constructed with a horizontal interconnect line **1910** segment and a 45° angle diagonal interconnect line **1920** segment. The interconnect line with angle A has a slope of n/m where y = x * tan(A). To provide a vertical rise of y, a 45° angle diagonal interconnect line **1920** of length $\sqrt{2}y$ is used. This 45° angle diagonal interconnect line **1920** also provides horizontal change of y. To provide the remainder of the horizontal change, a horizontal interconnect line **1910** of length x-y is used (where x equals the entire horizontal distance change for vertical distance change of y). Expressed only in terms of angle A and vertical distance y, the horizontal interconnect line **1910** is created with a length of y*cotan(A) - y = y(cotan(A)-1).

Figure 19b illustrates another way of calculating the lengths of the two sections. Referring to **Figure 19b**, an interconnect line with angle A (an angle between zero and forty-five degrees) is constructed with horizontal interconnect line **1950** segments and 45° angle diagonal interconnect line **1960** segments. The interconnect line with angle A has a slope of n/m where n = sin(A)*m. To provide a vertical rise of n, a 45° angle diagonal interconnect line **1960** of length $\sqrt{2}n$ is used. This 45° angle diagonal interconnect line **1960** also provides horizontal change of n. To provide the remainder of the horizontal change, a horizontal interconnect line **1950** of length m-n is used (where m equals the entire horizontal distance change for vertical distance change of n). Expressed only in terms of angle A and n, the horizontal interconnect line **1950** is created with a length of n/sin(A) - n.

The vertical distance change value of n is selected in a manner that best allows the manufacturer to manufacture a desired integrated circuit design.

> Specifically, a very small value of n approximates the A degree interconnect line very closely but can be difficult to manufacture. A large value of n will not closely approximate the desired line with an angle of A.
>
> To closely track the desired interconnect line with an angle of A, the simulated angle A interconnect line will cross back and forth across the ideal Euclidean interconnect line with an angle of A. Specifically, **Figure 20** illustrates how alternating pairs of horizontal interconnect lines **2010** and diagonal interconnect lines **2020** are used to create a close approximation to the desired interconnect line **2080** with angle A.

(*See* Specification page 40, line 1 to page 43, line 5.) Applicants submit that the description on pages 38-45 and the Figures 17-24 of the present application enable one of ordinary skill in the art to practice the claimed invention of claims 59-64. In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the §112, first paragraph rejection of claims 59 and 62, and their respective dependent claims 60-61 and 63-64.

II. Claim Rejections under 35. U.S.C. §102(b)

A. Claims 59-61

Claims 59-61 were rejected under §102(b) as being anticipated by Linsker. Claims 60-61, are dependent on claim 59. Claim 59 recites a method that simulates Euclidean wiring in an integrated circuit (IC) layout. The method determines a preferred wiring angle for a metal layer of the IC layout. The method determines, based on the preferred wiring angle, a ratio of wire segment lengths along a first direction to wire segment lengths along a second direction that is approximately 45 degrees from the first direction. The method uses the ratio to define a set of routes on the metal layer. Each route has a first set of wire segments along the first direction on the metal layer and a second set of wire segments along the second direction on the metal layer, such that each route in the set of routes effectively traverses on the metal layer along the preferred wiring angle.

Applicants respectfully submit that Linsker does not disclose, teach, or even suggest such a method. Linsker discloses techniques for wiring semiconductor chips that are mounted on a substrate. Hence, Linsker does not disclose, teach, or even suggest the method of claim 59, which defines simulated Euclidean routes in an IC layout.

Moreover, Linsker discloses wiring some planes in purely Manhattan directions while wiring other planes in diagonal directions. Linsker also discloses that the diagonal wiring on the diagonally wired planes can include meandering horizontal and vertical jogs. In Linsker, such jogs are used to circumvent obstacles. Linsker then provides certain wirelength savings that can be achieved by using such a wiring model instead of a wiring model that uses only Manhattan wiring directions. Linsker also compares these wirelength savings to wirelength costs of other wiring models that provide other wiring directions.

Applicants respectfully submit that none of this disclosure has anything to do with the method of claim 59, which recites a method that simulates Euclidean wiring in an IC layout by:

- determining a preferred wiring angle for a metal layer of the IC layout;
- determining, based on the preferred wiring angle, a ratio of wire segment lengths along a first direction to wire segment lengths along a second direction that is approximately 45 degrees from the first direction; and
- using the ratio to define a set of routes on the metal layer, where each route has a first set of wire segments along the first direction on the metal layer and a second set of wire segments along the second direction on the metal layer, such that each route in the set of routes effectively traverses on the metal layer along the preferred wiring angle.

On page 3, line 16 of the Office Action, the Examiner cites MANH/EUCL ratio as the ratio recited in claim 59. Applicants respectfully disagree with this characterization. The MANH/EUCL notation in Linsker specifies the wirelength cost of wiring a multi-chip module substrate with Manhattan wiring versus the wirelength cost of wiring such a substrate with Euclidean wiring. This has nothing to do with routing a metal layer based on a ratio of wire segments along two directions, where the ratio is based on the desired effective wiring direction of the metal layer.

Accordingly, Applicants respectfully submit that Linsker neither anticipates claim 59, nor renders this claim invalid. As claims 60-61 are dependent on claim 59, Applicants respectfully submit that claims 60-61 are also patently distinguishable from Linsker for at least the reasons discussed above in relation to claim 59.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the §102 rejection of claims 59-61.

B. Claims 62-64

The Examiner rejected claims 62-64 under §102(b) as being anticipated by Linsker. Claims 63-64 are dependent on claim 62. Claim 62 recites a method that simulates Euclidean wiring that determines a preferred wiring angle for a metal layer. The method determines, based on the preferred wiring angle, a ratio of wire segment lengths along a first direction to wire segment lengths along a second direction that is substantially orthogonal to the first direction. The method uses the ratio to define a set of routes on the metal layer. Each route has a first set of wire segments along the first direction on the metal layer and a second set of wire segments along the second direction on the metal layer, such that each route in the set of routes effectively traverses on the metal layer along the preferred wiring angle.

Applicants respectfully submit that Linsker does not disclose, teach, or even suggest such a method. Linsker discloses techniques for wiring semiconductor chips that are mounted on a substrate. Hence, Linsker does not disclose, teach, or even suggest the method of claim 62, which defines simulated Euclidean routes in an IC layout.

Moreover, Linsker discloses wiring some planes in purely Manhattan directions while wiring other planes in diagonal directions. Linsker also discloses that the diagonal wiring on the diagonally wired planes can include meandering horizontal and vertical jogs. In Linsker, such jogs are used to circumvent obstacles. Linsker then provides certain wirelength savings that can be achieved by using such a wiring model instead of a wiring model that uses only Manhattan wiring directions. Linsker also compares these wirelength savings to wirelength costs of other wiring models that provide other wiring directions.

Applicants respectfully submit that none of this disclosure has anything to do with the method of claim 62, which recites a method that simulates Euclidean wiring in an IC layout by:

- determining a preferred wiring angle for a metal layer;
- determining, based on the preferred wiring angle, a ratio of wire segment lengths along a first direction to wire segment lengths along a second direction that is substantially orthogonal to the first direction; and
- using the ratio to define a set of routes on the metal layer, where each route has a first set of wire segments along the first direction on the metal layer and a second set of wire segments along the second direction on the metal layer, such that each route in the set of routes effectively traverses on the metal layer along the preferred wiring angle.

On page 3, line 16 of the Office Action, the Examiner cites MANH/EUCL ratio as the ratio recited in claim 62. Applicants respectfully disagree with this characterization. The MANH/EUCL notation in Linsker specifies the wirelength cost of wiring a multi-chip module substrate with Manhattan wiring versus the wirelength cost of wiring such a substrate with Euclidean wiring. This has nothing to do with routing a metal layer based on a ratio of wire segments along two directions, where the ratio is based on the desired effective wiring direction of the metal layer.

Accordingly, Applicants respectfully submit that Linsker neither anticipates claim 62, nor renders this claim invalid. As claims 63-64 are dependent on claim 62, claims 63-64 are also patentably distinguishable from Linkser for at least the reasons discussed above in relation to claim 62.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the §102 rejection of claims 62-64.

C. Claims 65-68

The Examiner rejected claims 65-68 under §102(b) as being anticipated by Linsker. Claims 66-68 are dependent on claim 65. Claim 65 recites an IC layout that includes a plurality of circuit modules, and first, second, and third interconnect line layers. The first interconnect line layer has a first Manhattan preferred direction of interconnect lines. The second interconnect line layer has a second Manhattan preferred direction of interconnect lines. The third interconnect line layer has a first diagonal preferred direction and a set of routes that effectively traverse along the first diagonal preferred direction. Each particular route in the set of routes on the third interconnect line layer includes several alternating subsegments that alternate between only two directions. The two directions include one of the Manhattan directions and a direction that is 45

degrees with respect to the one Manhattan direction. Each particular route in the set of routes traverses on the third interconnect line layer effectively along the first diagonal preferred direction because of a ratio of the lengths of the subsegments along the two directions.

Applicants respectfully submit that Linsker does not disclose, teach, or even suggest the IC layout of claim 65. For instance, Linsker does not disclose, teach, or even suggest an IC layout that has:

- several circuit modules,
- a first interconnect line layer that has a first Manhattan preferred direction of interconnect lines;
- a second interconnect line layer that has a second Manhattan preferred direction of interconnect lines.
- a third interconnect line layer that has a first diagonal preferred direction and a set of routes that effectively traverse along the first diagonal preferred direction;
- where each particular route in the set of routes on the third interconnect line layer includes several alternating subsegments that alternate between only two directions, and the two directions include one of the Manhattan directions and a direction that is 45 degrees with respect to the one Manhattan direction, such that each particular route in the set of routes traverses on the third interconnect line layer effectively along the first diagonal preferred direction because of a ratio of the lengths of the subsegments along the two directions.

Linsker's FIG.3, FIG.4, and FIG.7 show wiring on a plane in a diagonal direction and show three directions to jog around connection sites. However, Linsker does not disclose, teach,

or even suggest a route with alternating subsegments where the alternating subsegments are in only two directions: a Manhattan and a diagonal direction. In contrast, Linsker shows three directions that are diagonal, vertical, diagonal, horizontal, and diagonal. Moreover, Linsker does not disclose, teach, or even suggest that each route traverses on the third interconnect line layer effectively along the first diagonal preferred direction because of a ratio of the lengths of the subsegments in the Manhattan and diagonal directions, as recited in claim 65.

Accordingly, Applicants respectfully submit that Linsker neither anticipates claim 65, nor renders this claim invalid. As claims 66-68 are dependent on claim 65, Applicants respectfully submit that claims 66-68 are also patentably distinguishable from Linsker for at least the reasons discussed above in relation to claim 65.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the §102 rejection of claims 65-68.

D. Claims 69-71

The Examiner rejected claims 69-71 under §102(b) as being anticipated by Linsker. Claims 70-71 are dependent on claim 69. Claim 69 recites a method of laying out an IC. The method places several circuit modules. The method routes first, second, and third interconnect line layers. The first interconnect line layer has a first Manhattan preferred direction of interconnect lines. The second interconnect line layer has a second Manhattan preferred direction of interconnect lines. The third interconnect line layer has a first diagonal preferred direction. The routing of the third interconnect line layer uses the first diagonal preferred direction to determine a mix of several alternating subsegments that alternate between only two directions. The two directions include one of the Manhattan directions and a diagonal direction that is 45 degrees with respect to the one Manhattan direction.

Applicants respectfully submit that Linsker does not disclose, teach, or even suggest the method of claim 69. For instance, Linsker does not disclose, teach, or even suggest a method of laying out an IC that:

- places several circuit modules;
- routes a first interconnect line layer that has a first Manhattan preferred direction of interconnect lines;
- routes a second interconnect line layer that has a second Manhattan preferred direction of interconnect lines; and
- routes a third interconnect line layer that has a first diagonal preferred direction, where the routing of the third interconnect line layer uses the first diagonal preferred direction to determine a mix of several alternating subsegments that alternate between only two directions, and the two directions include one of the Manhattan directions and a diagonal direction that is 45 degrees with respect to the one Manhattan direction.

Linsker discusses a connection arrangement for wiring planes. Linsker specifically discusses jogs around connection sites as part of a connection arrangement. Linsker shows three directions for each jog, whereas claim 69 recites a mix of alternating subsegments that alternate between only two directions. Moreover, since Linsker describes an arrangement, Linsker does not disclose a method that places circuit modules, routes first, second, and third interconnect line layers, and uses a first diagonal preferred direction to determine a mix of alternating subsegments that alternate between only two directions. Thus, Linsker does not disclose, teach, or even suggest several of the limitations recited in claim 69. If the Examiner disagrees with the

Applicant's position, Applicants respectfully request that the Examiner identify where Linsker discloses the above-recited limitations of claim 69.

Without such a showing, Applicants respectfully submit that Linsker neither anticipates claim 69, nor renders this claim invalid. As claims 70-71 are dependent on claim 69, claims 70-71 are also patentably distinguishable from Linkser for at least the reasons discussed above in relation to claim 69.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the §102 rejection of claims 69-71.

E. Claims 72-74

The Examiner rejected claims 72-74 under §102(b) as being anticipated by Linsker. Claims 73-74 are dependent on claim 72. Claim 72 recites a method of laying out an IC. The method places a plurality of circuit modules. The method routes first, second, and third interconnect line layers. The first interconnect line layer has a first Manhattan preferred direction of interconnect lines. The second interconnect line layer has a second Manhattan preferred direction of interconnect lines. The third interconnect line layer has a first diagonal preferred direction. Routing the third interconnect line layer uses the first diagonal preferred direction to determine a mix of several alternating subsegments that alternate between only two directions. The two directions include one of the Manhattan directions and a direction that is substantially orthogonal to the one Manhattan direction;

Applicants respectfully submit that Linsker does not disclose, teach, or even suggest the method of claim 72. For instance, Linsker does not disclose, teach, or even suggest a method of laying out an IC that:

- places several circuit modules;

- routes a first interconnect line layer that has a first Manhattan preferred direction of interconnect lines;
- routes a second interconnect line layer that has a second Manhattan preferred direction of interconnect lines; and
- routes a third interconnect line layer that has a first diagonal preferred direction, where routing the third interconnect line layer uses the first diagonal preferred direction to determine a mix of several alternating subsegments that alternate between only two directions, and the two directions include one of the Manhattan directions and a direction that is substantially orthogonal to the one Manhattan direction.

Linsker discusses a connection arrangement for wiring planes. Linsker specifically discusses jogs around connection sites as part of a connection arrangement. Linsker shows three directions for each jog, whereas claim 72 recites a mix of alternating subsegments that alternate between only two directions. Moreover, since Linsker describes an arrangement, Linsker does not disclose a method that places circuit modules, routes first, second, and third interconnect line layers, and uses a first diagonal preferred direction to determine a mix of alternating subsegments that alternate between only two directions. Thus, Linsker does not disclose, teach, or even suggest several of the limitations recited in claim 72. If the Examiner disagrees with the Applicant's position, Applicants respectfully request that the Examiner identify where Linsker discloses the above-recited limitations of claim 72.

Without such a showing, Applicants respectfully submit that Linsker neither anticipates claim 72, nor renders this claim invalid. As claims 73-74 are dependent on claim 72, Applicants

respectfully submit that claims 73-74 are also patentably distinguishable from Linkser for at least the reasons discussed above in relation to claim 72.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the §102 rejection of claims 72-74.

III. Claims 75-81

Applicants have added new claims 75-82. New claims 76-82 are dependent on new claim 75. New claim 75 recites a method of wiring an IC layout that identifies a preferred wiring angle for a metal layer of the IC layout. The method uses the preferred wiring angle to identify a proportion of wire segments along a first direction and wire segments along a second direction. The method uses the proportion to determine a set of routes on the metal layer. Each particular route has a set of wire segments along the first direction and a set of wire segments along the second direction such that the particular route effectively traverses on the metal layer along the preferred wiring angle.

Applicants respectfully submit that new claim 75 is patentable over Linsker because Linsker does not disclose, teach, or even suggest a method that wires an IC layout by:

- identifying a preferred wiring angle for a metal layer of the IC layout;
- using the preferred wiring angle to identify a proportion of wire segments along a first direction and wire segments along a second direction; and
- using the proportion to determine a set of routes on the metal layer, where each particular route has a set of wire segments along the first direction and a set of wire segments along the second direction such that the particular route effectively traverses on the metal layer along the preferred wiring angle.

Linsker compares line-lengths but in a context different than the context recited in claim 75. Linsker's line-lengths are in relation to total line length savings for different methods of routing. In contrast, claim 75 recites a proportion based on a preferred wiring angle. The proportion is of wire segments along a first direction to wire segments along a second direction. The proportion is issued to define routes on a metal layer that have two sets of wires in two directions such that each route effectively traverses on the metal layer along the preferred wiring angle .

Accordingly, Applicants respectfully submit that Linsker does not render claim 75 unpatentable for at least the reasons discussed above. As claims 76-82 are dependent on claim 75, Applicants respectfully submit that claims 76-82 are patentable over Linsker for at least the reasons discussed above for claim 75. Thus, Applicants respectfully request consideration and allowance of new claims 75-82.

CONCLUSION

In view of the foregoing, it is submitted that all pending claims, namely claims 59-82, are in condition for allowance. Reconsideration of the rejections and objections is requested. Allowance is earnestly solicited at the earliest possible date.

Respectfully submitted,

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